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LEAD SHOT: ITS DANGER TO WATER-FOWL[1]

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EACH year since the first fowler in America fired his muzzle-loading shotgun at a duck, water-fowl areas throughout the nation have been increasingly peppered with shot. Each year produced more and more duck hunters who, instead of using the old muzzle-loader, developed the modern double, repeating and automatic shotguns with smokeless powder and high velocity shells. Thus to-day, during the season, every duck flying over a blind is usually accompanied by a shower of shot, whether he is in gun range or not.

If a duck survives a hunting season, the chances are becoming increasingly greater that he will pick up, on his feeding grounds, enough lead shot to cause death by lead poisoning. This grave danger is not seasonal, like hunting, but is a threat whenever the duck is feeding. Nor is the shot covered up by sediment as rapidly as one would hope, but usually *remains available to water-fowl for many years.* It has been experimentally determined that the ingestion of six No. 5 shot by a duck is fatal, and even two or three shot are often fatal.

Lead poisoning of water-fowl is not new. In 1842 a paper was published in Berlin on the injurious effects of lead upon animals. In the February, 1894, issue of *Forest and Stream* Dr. George Bird Grinnell, famous hunter and naturalist, published an article on lead poisoning of water-fowl in Texas and North Carolina. In 1919, Dr. Alexander Wetmore investigated western duck sickness and lead poisoning in the water-fowl of the great marshes of the Bear River in Utah. In addition to other valuable information he discovered that six shot fed to a duck were always fatal. A partial bibliography of no less than 47 titles on lead poisoning of water-fowl is on file in the United States Biological Survey at Washington.

Many water-fowl refuges in the state of Minnesota and doubtless throughout the nation were old and much-hunted duck lakes long before they were declared refuges. While such a refuge affords safety from hunters it may be a veritable death-trap for water-fowl because of the presence and availability of the old lead shot on the bottom. This potential death by lead poisoning, while ever present, is greatly increased during the hunting season because water-fowl tend to concentrate on refuge areas during this period. Furthermore, death by lead poisoning becomes an ever greater danger if refuge lakes are located on areas where there is a scarcity of native gravel suitable for consumption by water-fowl. Grit is as essential and vital to water-fowl as food and water, and if the grit is abundant and readily available it is eaten in liberal quantities and passes through the digestive systems more rapidly. Under conditions of grit scarcity the grit may be conserved and ground over longer periods of time. When grit is ingested in abundance the lead shot picked up also have greater opportunities of being passed through the digestive system before their poisoning effect can be felt. Apparently a duck does not discriminate between a lead shot and a piece

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of granite or quartz of the same size. If it did, lead poisoning, the most serious disease problem in water-fowl management to-day, would not exist.

With the foregoing in mind it seems to be very poor water-fowl management to turn old duck-shooting areas into refuges without first determining the relative amounts of shot and gravel that are available to water-fowl. Based upon this premise an investigation was begun to examine, methodically, lake-bottom samples and to study the *availability* of lead shot and gravel to water-fowl, the chief interest being lead shot.

The samples in the study were taken either with a Peterson dredge, such as is used in limnological work, or with a post-hole digger. For each sample the amount of bottom surface covered was one square foot. Precautions were taken to sample only the five to six inches at the surface of the lake bottom, that area in which the water-fowl are most accustomed to feed.

As the ice ranged from three to 30 inches thick a crew of WPA laborers was obtained to assist by cutting the holes through the ice. The lakes studied were either transected at right angles by two lines of holes or a series of holes was made around the entire lake as close to shore as possible.

This method was used on all the duck lakes surveyed except Heron Lake. Because of the large size of this lake—20 miles long and one mile wide—it was planned first to take samples from several areas that were most heavily hunted and then to take samples of the entire lake in the manner in which the other lakes were surveyed. However, circumstances prevented completion of these plans and only four heavily shot areas were surveyed with a total of 36 samples. Probably a more accurate picture of lead-shot conditions on Heron Lake could have been made if 100 or more samples could have been taken.

A rough map was drawn of each lake, and the number and location of each sample was recorded when it was made. Each sample was given a tag indicating the name of the lake, number of the station, depth of water and type of bottom. By so doing it was possible to determine, roughly the distribution of the shot over a given area or the entire lake. It was found that the shot was more or less evenly distributed on the bottoms of those lakes examined. The size of the area over which a single charge of shot is scattered is so great that a rather general distribution of spent shot over a lake bottom is assured. Tests under field conditions showed that the shot from a 16-gauge high velocity shell may carry nearly 300 yards and that the pattern may be spread over a distance of 48 yards.

After the samples were washed through special sieves in the laboratory the residue of shot, seeds, gravel, small snails, clams, etc., was dried and separated into vials for further study. In those samples containing lead the shot was counted and the amount was added to the corresponding tag. The duck lakes surveyed represented both those closed to hunting and those on which hunting still occurs. By so doing it was possible to make a comparison of lead-shot conditions in the two kinds of lakes.

In three lakes in the Carlos Avery Refuge in Anoka County, Minnesota, much of the lead shot from past years' shooting still lies within a few inches of the surface of the lake bottom and is undoubtedly available to feeding water-fowl. In two of the lakes, Little Coon and East Twin, at the time of the study no shooting had been allowed for five years, and, in spite of this, shot were recovered from the bottom samples at the rate of one shot per 3.5 square feet, and one per 1.66 square feet, respectively. These averages are based upon 28 and 25 samples.

The third lake within the refuge, West Twin Lake, was protected from all shooting for four years, but had been opened to hunting for one year at the time the work was done. Here 27 samples yielded 12 shot or an average of one per 2.25 square foot, a figure quite comparable with these from the other two refuge lakes.

Three nearby lakes on which ducks are hunted were studied for comparison. They were Boot Lake, Rice Lake and Tamarack Lake, all in Anoka County within three miles of the Carlos Avery Refuge Lakes. The incidence of shot varied from one per 1.25 square feet in Rice Lake to one per 8 square feet in Boot Lake, but the average for these three lakes, all continuously open to hunting, was one shot per 2.04 square feet. The distribution of the shot over the six lakes was general.

To make matters worse, there is a very marked scarcity of gravel in the Carlos Avery Refuge lakes. In fact, because of its geological formations the major portion of the entire county has very little native gravel available or suitable either to water-fowl or upland game. It seems logical to assume that any duck lake, refuge or otherwise, which has a very marked deficiency of gravel for water-fowl but at the same time has lead shot easily available is that much more dangerous to water-fowl, and the total amount of gravel in the 80 samples taken on the three Carlos Avery Refuge lakes weighed but 2.3 grams. Over 37 per cent. of the total number of samples from these refuge lakes were entirely devoid of gravel. Since the average duck gizzard contains two to three grams of gravel, a duck on these lakes would have to cover at least 80 square feet of lake bottom in order to find sufficient gravel for his needs. However, the same duck has but to forage 15 square feet in order to find enough lead shot to cause death by lead poisoning!

Such a condition as that found on the Carlos Avery Refuge lakes *might* be partially remedied by simply distributing gravel of suitable size and kind on the lakes during the winter months. In the spring when the ice melts the gravel sinks to the bottom and is thus available to water-fowl.

Heron Lake, Jackson County, Minnesota, is located about 150 miles southwest of Minneapolis and 10 miles west of Windom. This lake has been a famous water-fowl hunting area for over 75 years. At one time it was one of the greatest canvas-back lakes in the state, but since practically all the wild celery has disappeared very few ducks of this species visit it. To-day it is a favorite mallard lake.

Heron Lake is divided into three parts, the smallest of which is on the north end and is called Duck Lake. The other two make up the bulk of the main lake, and all three comprise an area approximately 20 miles long by one mile wide. The average depth of the portions studied was between 18 and 24 inches. The bottom is hard clay with one to three inches of mud on top. The dominant vegetation is river bulrush (*Scirpus fluviatilis*), which has but slight value as a duck food. About 2,000 seeds of this aquatic plant were taken from only 36 samples. Gravel, suitable for water-fowl, was not scarce, only four out of the 36 samples being without grit. The 36 samples were taken from four different areas that had been hunted most intensively during the past years.

Only one of the four samples taken on Duck Lake contained lead, but this amounted to three shot. Three samples taken from the west side produced a total of four shot. Twelve samples of the 23 taken on the southeast and south sides of upper Heron Lake yielded a total of 46 shot. One of these samples, covering one square foot, contained 11 shot!

The average density of shot on the total area surveyed amounts to 1.5 shot for every square foot of bottom. While this

density is very high, it perhaps would be higher and more general in distribution if the lake were open to public hunting. For many years the entire lake has been leased to individuals and groups of hunters who shoot over definite areas and prevent the general public from entering their private domain.

The bottom of Heron Lake would probably hold lead shot easily available to waterfowl for many years to come, even though a shotgun were never to be discharged over it again. The rate of deposition is very slow, as revealed by a thin covering of mud. These two factors, especially when combined with heavy hunting, constitute a great lead-poisoning hazard for waterfowl.

Very little can be done to lessen the danger of lead poisoning on a lake of this type. To stop the increase of lead by closing Heron Lake to hunting would be futile because the waterfowl would only concentrate on it during the hunting season, causing a more severe increase in lead poisoning mortality than already exists. Such a procedure would also meet a tremendous opposition by those who hunt the lake. Such drastic measures as trying to cover the lead or remove it would not only be economically impractical but would destroy valuable waterfowl foods for several years to come.

Most waterfowl lakes in Minnesota may be classified into three major groups: tamarack-bog lakes, like Rice and Tamarack lakes in Anoka County; prairie lakes, like Heron Lake and those on Carlos Avery Refuge; and river-lakes, like those common along the Minnesota River. The lakes surveyed to date fall into these three classes and are typical of each class.

The river-lakes surveyed for lead shot and gravel available to waterfowl included five large lakes on the Minnesota River, owned or leased by private gun clubs. The Minnesota River Gun Club, which owns one lake, is located across the river from the west end of Fort Snelling, in Dakota County. The Long Meadow Gun Club controls two lakes, and is located south of Minneapolis, in Hennepin County. The Benz Club owns two lakes, and is located on the south side of the river and a few miles downstream from Shakopee. The level of these lakes is usually maintained by dams and springs.

The data reveal that of the three major classes of duck lakes the river-lakes have the least lead available to waterfowl, an average of one shot per 2.97 square feet in the 107 samples from three areas studied. This fact may be due chiefly to three factors. First, river-lakes in general have the highest rate of deposition of any type of duck lake because of the annual flooding of the river; thus the shot is more rapidly covered up and made unavailable to ducks. Second, practically all the hunting on these three areas is pass shooting; thus less shot falls in duck-feeding areas on the lakes. Third, these particular lakes have been leased or owned by private parties for many years, and therefore the number of hunters per season and per day is limited. Thus less shot is scattered over the feeding grounds for the ducks to pick up.

If these river-lakes were open to the public a far greater incidence of lead shot would undoubtedly occur, as all three areas are within 30 miles of the Twin Cities. The data reveal also that the river-lakes have more gravel available to waterfowl than the other types of duck lakes surveyed.

In addition to the lead shot recovered from the bottom samples, a total of 24 species of aquatic plant seeds were found. The number of species in each lake ranged from two to eleven. Such important waterfowl foods as *Sagittaria*, *Scirpus*, *Najas*, *Polygonum*, *Zizania* and nine species of *Potamogeton* were identified.

The number of shot found in this study show how widely distributed and easily

accessible to water-fowl lead shot are, and how important is the need of control. Professor R. L. Dowdell, of the School of Mines, and Dr. R. G. Green, of the School of Medicine, both of the University of Minnesota, have devised an alloy of magnesium and lead to be used in the manufacture of shot. Shot made of this alloy disintegrates rapidly in water due to the action of magnesium. Even if these small particles of disintegrated lead are picked up by a duck they are not retained in the gizzard. Whole pellets eaten by the bird decompose into small fragments, which are almost completely eliminated in 48 hours. This non-toxic shot in no way affects the pattern of a modern shotgun. It appears to offer an early solution of the problem. The data here presented emphasize that when the commercial production of a non-toxic shot becomes feasible the change should be made even if compelling legislation is necessary to assure it.

Little can be done about the shot that already lies on the bottoms of many thousands of duck lakes throughout the nation; therefore, in conclusion, it seems that setting aside an old hunting area for a duck refuge, as has often been done, is not wise if the bottom of that particular lake has in it considerable lead shot available to water fowl. To allow ducks to concentrate during the hunting season on a refuge full of available shot is comparable to turning broods of quail or pheasants into coops contaminated by disease. Before any water-fowl area previously used for duck shooting is declared a refuge, a thorough survey and analysis, of at least the feeding grounds of that area, should be made to determine the relative amounts of lead, gravel and food available to water-fowl.